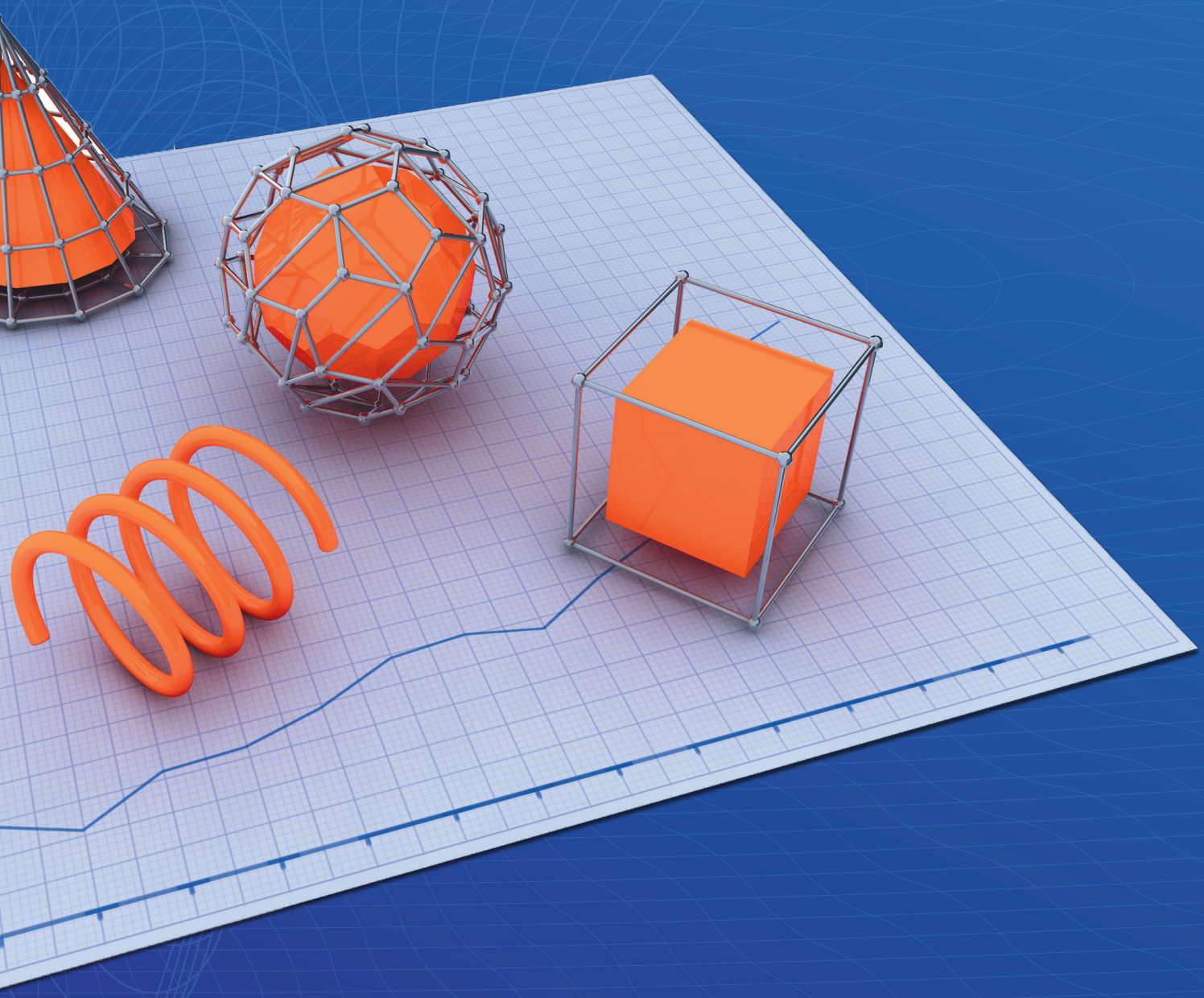
The Open University

Developing Mathematical Resilience



CREET

The Centre for Research in Education and Educational Technology

This project is just one of the many innovative research projects being undertaken within the Centre for Research in Education and Educational Technology (CREET). CREET is one of the leading education research units in the UK. It is an internationally respected centre of excellence, pursuing innovative and rigorous research that influences policy and practice.

To find out more about the work of the centre go to:

www8.open.ac.uk/creet/main

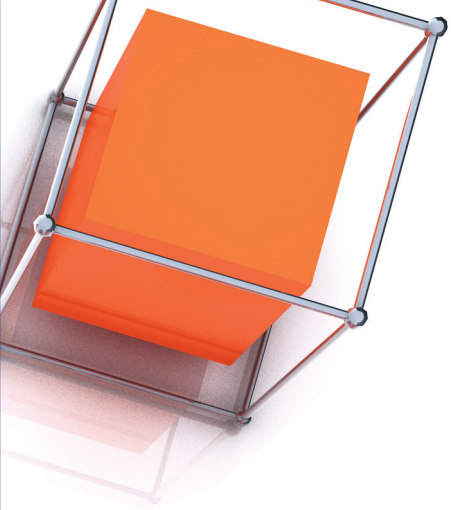
The Centre for Research in Education
and Educational Technology (CREET)
The Open University
Stuart Hall Building (Ground Floor)
Walton Hall
Milton Keynes
MK7 6AA

Tel: +44 (0)1908 655364

CREET-Enquiries@open.ac.uk

For information about applying for postgraduate study:
www8.open.ac.uk/creet/main/postgraduate

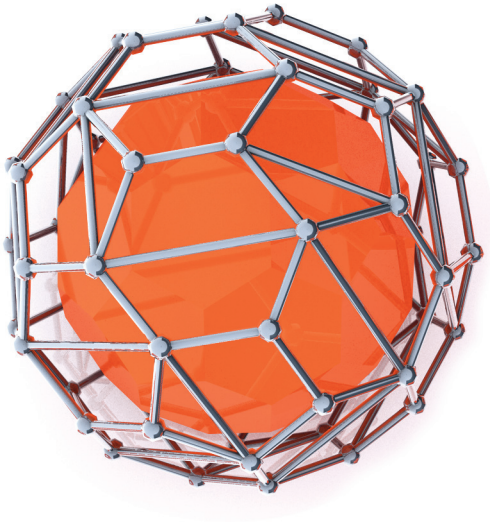
For research student enquiries:
CREET-Student-Enquiries@open.ac.uk



WHAT IS THE BACKGROUND TO THE RESEARCH?

Many people find it difficult to take part in mathematical learning, to the point where they exhibit anxiety or at least avoid engaging in any activity that could require mathematical reasoning. In this research we work with teachers in school to seek to develop a positive construct in learners, we call this construct ***mathematical resilience***. Our previous reading of related literature and our experience has led us to believe that when teachers employ particular teaching approaches they help their students overcome negative attitudes to mathematics and they develop mathematical resilience. The term 'mathematical resilience' is defined as that quality by which some students approach mathematics with confidence in a successful outcome to their effortful work, persistence in the face of difficulty and a willingness to discuss, reflect and research. Such resilience allows learners to overcome the barriers that learning mathematics can present. All learning requires resilience but we contend that the resilience required for learning mathematics ('mathematical resilience') is a particular construct as a consequence of various factors including the type of teaching often used, the nature of mathematics itself and pervasive beliefs about mathematical ability being 'fixed'.

We are told by Ofsted that much of the teaching that young people encounter teaches them how to pass examinations but not to develop any strategies to overcome any barriers that might present. Ofsted reports (e.g. 2008, 2006) say that the most common experience of young people in mathematics



classrooms is a focus on acquisition of skills, solution of routine exercises, preparation for tests and examinations and a need for speed in calculations. These practices are known to serve to increase anxiety (Ashcraft 2002) and act against establishing mathematical resilience.

When teachers work with their students in such a way that students are enabled to become more mathematically resilient they allow learners to adapt positively to difficulties presented when studying mathematics. This research begins to seek answers to the problem discussed in the STEM agenda (DFES 2006), as students who are mathematically resilient are more likely to be in a position to consider studying mathematics beyond compulsory age. By naming and defining the construct of 'mathematical resilience', we argue that teachers and policy makers will be enabled to develop it and to measure how successful they have been in enabling their students to become mathematically resilient

Mathematical resilience is important if we are to educate students to use mathematics and *function mathematically*; as opposed to simply pass examinations. However, our initial outcomes suggest that this is not an either/or situation; mathematically resilient students will have the skills they need to decide what an examination question is asking of them but they will also have the skills needed to function mathematically in the world beyond school, and the willingness to continue their mathematical development as and when needed, and that is important. The development of mathematical resilience also

requires students to acquire a reflective and thoughtful stance towards learning mathematics. Resilient students know that, if they think hard, talk to others, read about mathematical ideas and reflect on the information gained, they will be able to make headway with seemingly difficult ideas and problems

Our research has focused on three schools taking a different creative approach with each. In each school we have worked collaboratively with teachers in planning and delivering approaches to teaching mathematics which have the potential to increase the mathematical resilience of their students. We have critically evaluated each intervention and have already published in teacher focused journals whilst we prepare academic articles.

WHAT WERE THE OUTCOMES OR IMPACTS?

The small scale of the current study makes any outcomes tentative at the moment. However, one mathematics department that we have worked in have maintained their GCSE A*-C percentage at 48% despite major upheavals and shortcomings in staffing. Evaluations of the other projects show encouraging short term impacts.

We have published the following articles on mathematical resilience:

Lee, C. and Johnston-Wilder, S. 2010. *Children overheard, mathematical resilience* Mathematics Teaching MT218i.

Ward-Penny, R. Johnston-Wilder, S. & Lee, C. (2011) Exit Interviews: *Exploring the Experiences of Undergraduates Choosing to Leave Mathematics Behind*, For the Learning of Mathematics, Vol 31(2) pps. 21-26

Johnston-Wilder, S. and Lee, C. 2010. *Mathematical Resilience*, Mathematics Teaching, 218: 38-41.

We have presented at the following conferences:

Johnston-Wilder, S. and Lee, C. 2008. *Does Articulation Matter when Learning Mathematics?* Proceedings of the British Society for Research into Learning Mathematics 28(3).

Johnston-Wilder, S. and Lee, C. 2010. *Developing Mathemtical Resilience,* Paper presented at the 2010 BERA annual conference at Warwick University.

WHAT WAS THE INTERVENTION/TEACHING AND LEARNING PROCESS?

The research focuses on changing the ethos in mathematics teaching from a focus on rehearsing isolated skills and content to active learning and involvement of the students in the process of coming to know mathematics. In order to do this we have worked collaboratively with the teachers in school by:

1. Team teaching with staff of one school to enable students to produce videos demonstrating their mathematical learning. The students evaluations of the video lessons show that the lessons enabled the students to consolidate existing learning, rehearse and link their ideas, articulate their learning clearly so that they understood how much they knew and to teach themselves more about the ideas. This intervention took place over five days.

2. Working with the drama department in one school to explore how drama could enable students to use mathematics functionally. We discussed how the two departments could work together to provide contexts in which the students had to use mathematics. This resulted in a day planned jointly by the drama and mathematics teachers in which the students used mathematics in a realistic cops and robbers drama. We found that this approach was successful in that the teachers were thinking about enabling the students to function mathematically during the day but it was limited by some lack of confidence in their subject knowledge in one of the mathematics teachers. This intervention took place over three days, funded by the school.

3. Facilitating a mathematics department's consultation of its students with a view to changing practice to more nearly meet the students' needs in learning mathematics. Working with representatives of the students to devise, administer and analyse a questionnaire concerning their views about learning mathematics and how it could be improved. We also modelled innovative ways of learning mathematics so that the students could decide if they preferred the new approaches to the current ways that they learned mathematics. The student representatives also kept journals of their mathematical learning experiences and we collaborated with the students to use the journals to devise a letter to their teachers about

ways that they felt helped them to learn mathematics. In this intervention the students acted as advocates for their fellow students and their evaluations show how their mathematical resilience developed alongside their reflective stance to the ways of learning they were offered. This intervention took place over three days, funded by the school.

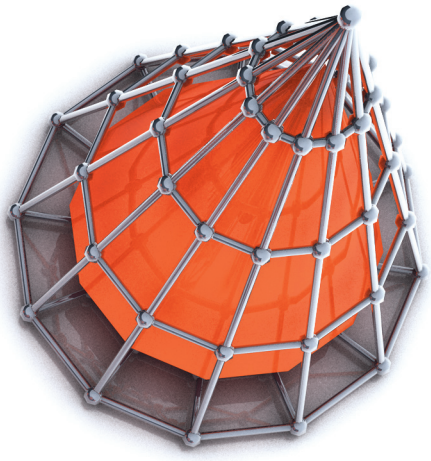
These approaches show how we can consider developing mathematical resilience in schools and the impact that such approaches could have. However a longer term study is needed to establish and embed long term approaches to teaching that build resilience over time. We also need to develop a reliable, valid and sensitive measuring instrument to tell us not only the current state of resilience in the school but also if and by how much it increases with the interventions.

HOW WAS THE RESEARCH CARRIED OUT?

Our research was based on considering in what way our professional practice within the schools was changing the teaching in the schools. We wanted to know if the teaching approaches that we advocated made a difference to the mathemtical resilience of the school students and also how the teaching in the schools was affected.

We used questionnaires to measure changes in mathematical resilience over time. We also gathered interview data with both teachers and students in order to evaluate the effects on teaching and learning. We have evidence from the students themselves in terms of their written journals. Our final source of data is our own field notes in terms of the planning for the days and reflections following the days in school.

WHAT MIGHT THE IMPLICATIONS OF THE RESEARCH BE FOR POLICY MAKERS/ PRACTITIONERS



There is the potential here for huge impacts for both policy makers and practitioners. If we can measure increase in mathematical resilience then we will be in a position to use such an assessment to drive changes in teaching to increase the use of approaches that increase mathematical resilience. As we have said above this is not an either/or situation, developing mathematical resilience enables students to attain well in exams and be in a position to favourably consider further study. The converse is not true working in a ‘drill and practice’ or ‘teaching to the test’ way may increase attainment but it does not increase mathematical resilience and therefore limits students’ mathematical choices in later life.

Developing Mathematical Resilience

Clare Lee
The Open University
clare.lee@open.ac.uk

Sue Johnston-Wilder
University of Warwick
sue.johnston-wilder@warwick.ac.uk

Design & illustration: Paul Wootton (www.graphicnet.co.uk)

The Open University